SAMMAMISH PLATEAU
SINCE 1948
WATER AND SEWER DISTRICT

RECEIVED
MAR 23 2012
By

March 22, 2012

Evan Maxim
Senior Planner
City of Sammamish
801 228th Ave SE
Sammamish, WA 98075

**RE: Critical Aquifer Recharge Areas**
**Sammamish Environmentally Critical Area Regulations Update**

Dear Evan:

Thank you for taking the time to review the proposed update to the City of Sammamish's Critical Area Regulations, specifically those relating to the Critical Aquifer Recharge Areas (CARA). As noted during our discussion, there are two areas where the Sammamish Plateau Water & Sewer District has concerns; 1) stormwater discharged through groundwater injection wells and 2) geothermal wells. These concerns are especially high in the Class 1 and 2 CARA, which represent drinking water wells 1-5 year and 10-year Wellhead Protection Zones, where a ban on injection should be seriously considered.

Injection wells are subject to Chapter 173-218 WAC – Underground Injection Control Program. In addition, Chapter 173-200 WAC - Water Quality Standards for Groundwaters of the State of Washington, should be reflected in the code. This chapter includes the State's antidegradation policy for groundwater.

The City's requirements for stormwater infiltration, while admirable, must be balanced with the potential impacts this may cause to the groundwater, particularly if the stormwater is untreated. The current City regulation does include language suggesting development may be conditioned to prevent groundwater degradation, and these requirements should be continued and strengthened.

In addition, the District has provided the most up-to-date District wellhead protection areas in shapefile format, per your request.

Sincerely,

Jay Regenstreif

Jay Regenstreif, P.E.
Planning Engineer

EXHIBIT NO. 57

12-03-36CARA Comment March 2012.docx

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## Debbie Beadle

**From:** ebwelch@u.washington.edu
**Sent:** Tuesday, March 27, 2012 7:24 AM
**To:** Debbie Beadle
**Cc:** jim@officefinder.com
**Subject:** Re: ECA Website Information
**Attachments:** Big_Picture_Maine_2012.pdf; Samplancom.doc

**Follow Up Flag:** Follow up
**Flag Status:** Flagged

Debbie: Here are my written comments invited by the Planning Commission, especially Mike Collins, at the March 15th meeting. I am also attaching a power point on the subject of lake protection and management presented to a Main audience by Ken Wagner, a limnologist, colleague and friend. Many of the points in my comments are also made by Wagner and with corroborating evidence. If the commission would like me to go through Wagner's presentation, explain points and/or answer questions, I would be glad to do that. Gene Welch

On Tue, 13 Mar 2012, Debbie Beadle wrote:

> Date: Tue, 13 Mar 2012 17:13:18 +0000
> From: Debbie Beadle <dbeadle@ci.sammamish.wa.us>
> Subject: ECA Website Information
>
>
> The city received Best Available Science (BAS) reports from the
> consultant related to Critical Aquifer Recharge Areas, Frequently Flooded Areas, and Seismic Hazard areas, on Friday March 9, 2012. Unfortunately due to technical difficulties, the BAS Reports could not be posted on the website until today (March 13).
>
>
>
> The BAS reports are now available on the website. The city has also
> provided the Planning Commission with a cover memo and some updated materials for the Resource Guide.
>
>
>
> Thank you
>
>
>
> Debbie Beadle
>
> Administrative Assistant to the Community Development Director/Deputy
> Director
>
> Community Development Department
>
> City of Sammamish
>

EXHIBIT NO. 58.

> (T) 425-295-0525
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> Please be aware that email communication with Council Members or City staff is a public record and is subject to disclosure upon request.
>

Thoughts on lake and stream protection in developing watersheds

The evidence is strong that land development affects water quality and the character of biota in bordering lakes and streams. This is often difficult for land owners to accept in the case of their individual 50 feet or so of property along the shore of a lake or stream. However, it's not the "first straw", but the "last straw" that produces the effect that future generations have to live with. That's why we determined the effect of eventual "build out" in the whole drainage on the long-term effect of development on Lake Sammamish water quality (Perkins et al., 1997). By treating each case separately, the short-term effect may be benign, but eventually there is an adverse cumulative effect.

The water quality of Lake Sammamish is better today than before sewage and dairy waste were diverted in 1968, but not before Europeans arrived. To maintain the lake's quality for generations to come, in the face of increasing population and development will, in my opinion, require the strictest rules possible that everyone, no exception, must adhere to.

Many land owners want to know just how close they can build, or how few trees they must leave, or how clear a view/access to the water's edge can be tolerated - and they want to see the supporting scientific evidence to the nearest ten feet. A more watershed and lake/stream friendly question would be how to utilize the property causing as little foot print as possible. After all, Lake Sammamish and its tributary streams are everyone's responsibility to hand over in good condition to succeeding generations.

Phosphorus is the key to plant and animal productivity and water quality in Western Washington lakes. Land with single family residences yields six times more phosphorus than forested lands. Part of the reason is that trees intercept rain and slow the rate of runoff and hence erosion. Also, impervious surfaces collect sediment and debris that quickly runs off with storms and soils contain phosphorus. Additional sources of phosphorus are lawn fertilizer and pet feces. The nutrient most important for lawns is nitrogen; plants need 10-15 times more nitrogen than phosphorus and enough phosphorus is already present. So why not go to phosphate-free fertilizer in the whole watershed? That should not obviate minimizing/treating storm runoff, because suspended sediment itself degrades water quality and some phosphorus is removed too. More on treatment later.

The "last straw" approach was used to estimate the effect of development on Lake Sammamish quality. That is, and given conditions in 1992, what would the lake look like at build out? By 1975, about 17 % of the watershed was developed, 35 % by 1992, and 58 % was projected by build out. Forest cover in the east and west-side sub basins would decrease by 90-95 % from 1975, depending on whether there was 65 or 30 % forest retention on land to be developed. That was expected to increase phosphorus input by 20 % from 1992 and reduce summer water transparency by about 25-30 % from 4.9 meters to 3.4 - 3.7 meters (16 to 11 - 12 feet), depending on forest retention.

Phosphorus input to Lake Sammamish

| | input, kg/yr | inflow concentration, ppb |
|---|---|---|
| Pre-diversion of waste water | 20,200 | 144 |
| Post-diversion | | |
| 1975 | 13,300 | 95 |
| 1992 | 18,100 | 129 |
| Build-out | 21,700 | 156 |

ppb = parts per billion or µg/L

So replacement of forest with residential development will gradually, but ultimately reduce the clarity of the lake. However, if only a few properties for development are evaluated at a time, the effect on the lake's 350 million cubic meters would be undetectable. Even the effect of storm water from a pipe on the near shore environment will be difficult to detect, as shown in a study of three large storm water inputs from the intensely developed west side in the mid 1970s. That is despite the six-fold difference between lake (18 ppb) and storm water (109 ppb) phosphorus concentrations. Wind generated water motion quickly transported the incoming storm water. That is why the "first straw" approach will not maintain Lake Sammamish quality over the long term.

Smaller lakes, however, may be more vulnerable to shorter-term effects because their lake volume (for dilution)-to-watershed area ratios are smaller: Lake Sammamish, 1.56; Pine Lake, 0.87. A study of 23 ponds (ave. 0.9 acres) in Wisconsin showed that several biological characteristics were related negatively to percent lawn cover (Dodson, 2008). More than 30 percent of the pond's watersheds were in lawn, and pesticide use in lawn care was discussed as the probable cause.

Phosphorus and suspended sediment in stormwater can be partially removed by various processes - the most common being wet pond retention basins that allow time to settle particulate matter. However, these ponds remove only half the total phosphorus on average and little of the soluble fraction. Thus, stormwater passing through a retention basin would probably still enter the lake with more than 50 ppb (westside stormwater 109 ppb, mid 1970s), while the lake's surface water contains about 18 ppb, similar to runoff from forested land. While retention can mitigate some of the effect of development, forest (and other woody vegetation) retention should be strongly emphasized. Tree retention on properties should be encouraged by explaining their benefits: 1. rainfall interception reducing rate of runoff, erosion and phosphorus and sediment transport, 2. reduce home heat loss by protection from wind, 3. carbon sequestering, 4. beautifying - natural appearance, 5. bird habitat.

There are more efficient methods to remove pollutants from stormwater, but they have expensive capital and operating costs. Moreover, costs increase exponentially as the residual pollutant concentration decreases. To reduce stormwater from 100-200 ppb phosphorus to 20 ppb, the normal concentration in forest runoff, would be extremely expensive. Maximizing forest retention is by far the cheapest option to protect the lake long term, and furnishes other benefits as well.

Streams are adversely affected by development. Their biota are very sensitive to rate of runoff, which increases with the watershed fraction covered by impervious surface. A nine-stream study in western Washington in the mid 1990s showed that the quality of the invertebrate organisms began to decline as the fraction of impervious surface exceeded only 5 % (May et al., 1997)! Other investigators have observed similar results. The principal effects on streams are physical. Changes to the stream channel by scouring, bank erosion and sediment deposition are mostly due to higher-than-natural flows. The changes degrade the habitat for invertebrate organism and fish, especially salmonid fishes. To help avoid such adverse effects, tree and woody vegetation removal, impervious surfaces and stream-bank encroachment should be minimized.

Gene Welch
Limnologist, Prof. Emeritus
March 28, 2012

References

Dodson, S. I. 2008. Biodiversity in southern Wisconsin storm-water retention ponds: Correlations with watershed cover and productivity. Lake and Reserv. Manage. 24:370 380.

May, C.W., E.B. Welch, R.R. Horner, J.R. Karr and B.W. Mar. 1997. Quality indices for urbanization effects in Puget Sound lowland streams. Dept. of Civil & Environmental Engineering, Univ. of Washington, Water Resources Ser. Tech. Rep., No. 154.

Perkins, W. W., E. B. Welch, J. Frodge and T. Hubbard. 1997. A zero degree of freedom total phosphorus model; 2. Application to Lake Sammamish, Washington. Lake and Reserv. Manage. 13:131-141.

Welch, E. B., C. A. Rock, R. C. Howe and M. A. Perkins. 1980. Lake Sammamish response to wastewater diversion and increasing urban runoff. Water Research 14:821 828.

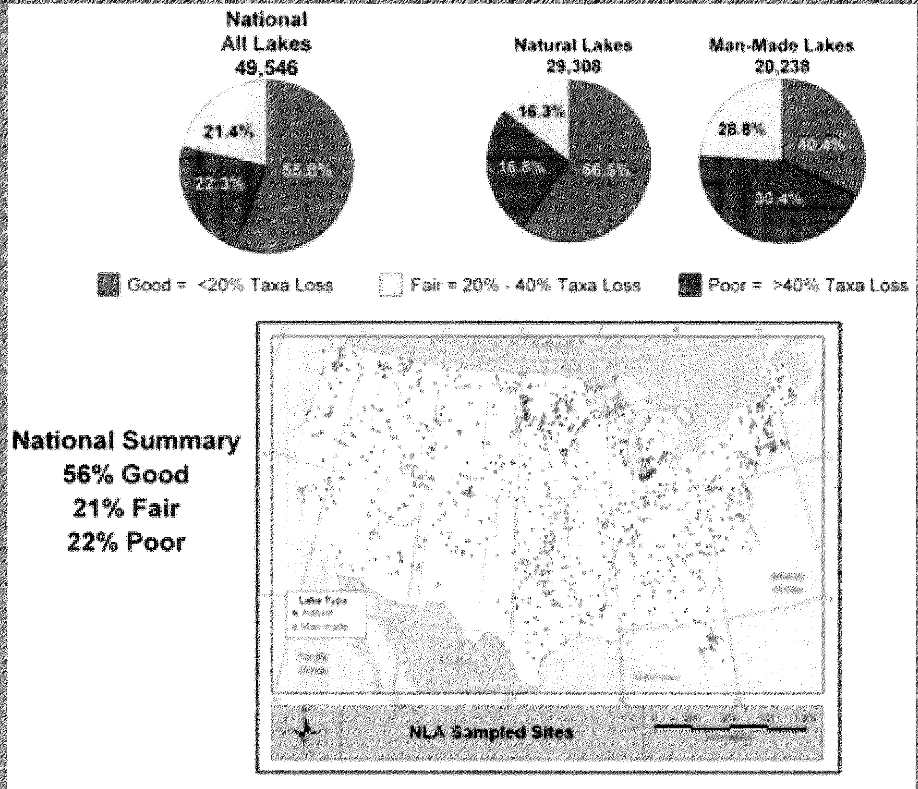
# Seeing the Big Picture: Options and Limits for Management to Enhance Lakes

Ken Wagner, PhD, CLM

Water Resource Services

WRS

# How are we doing with lake management?

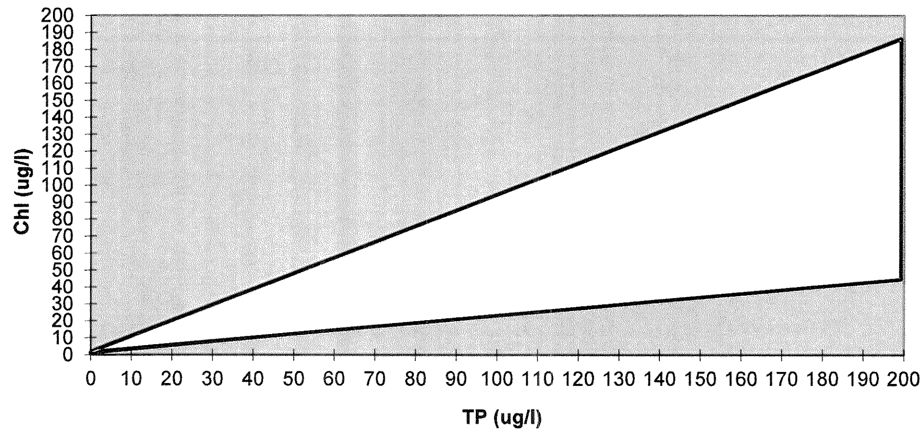



National Summary
56% Good
21% Fair
22% Poor

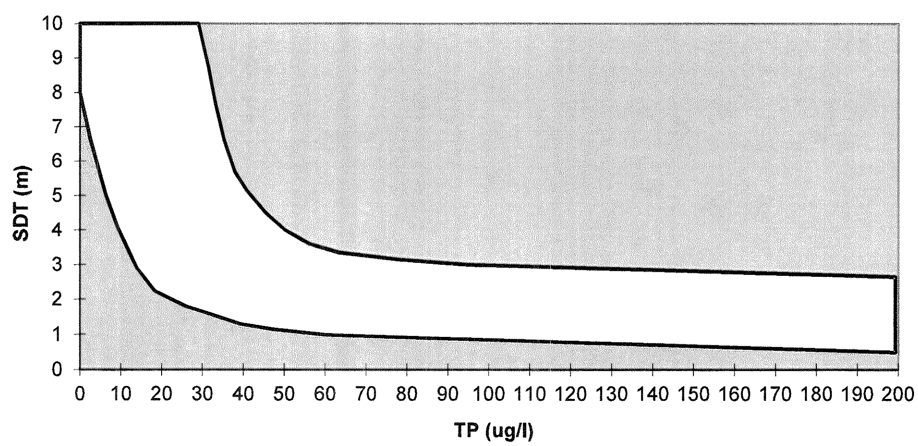
According to the National Lakes Assessment last year, almost half of our lakes are in less than good shape nationwide as a consequence of nutrient pollution. ME doing better…

# The impact of phosphorus

Total Phosphorus vs. Chlorophyll a

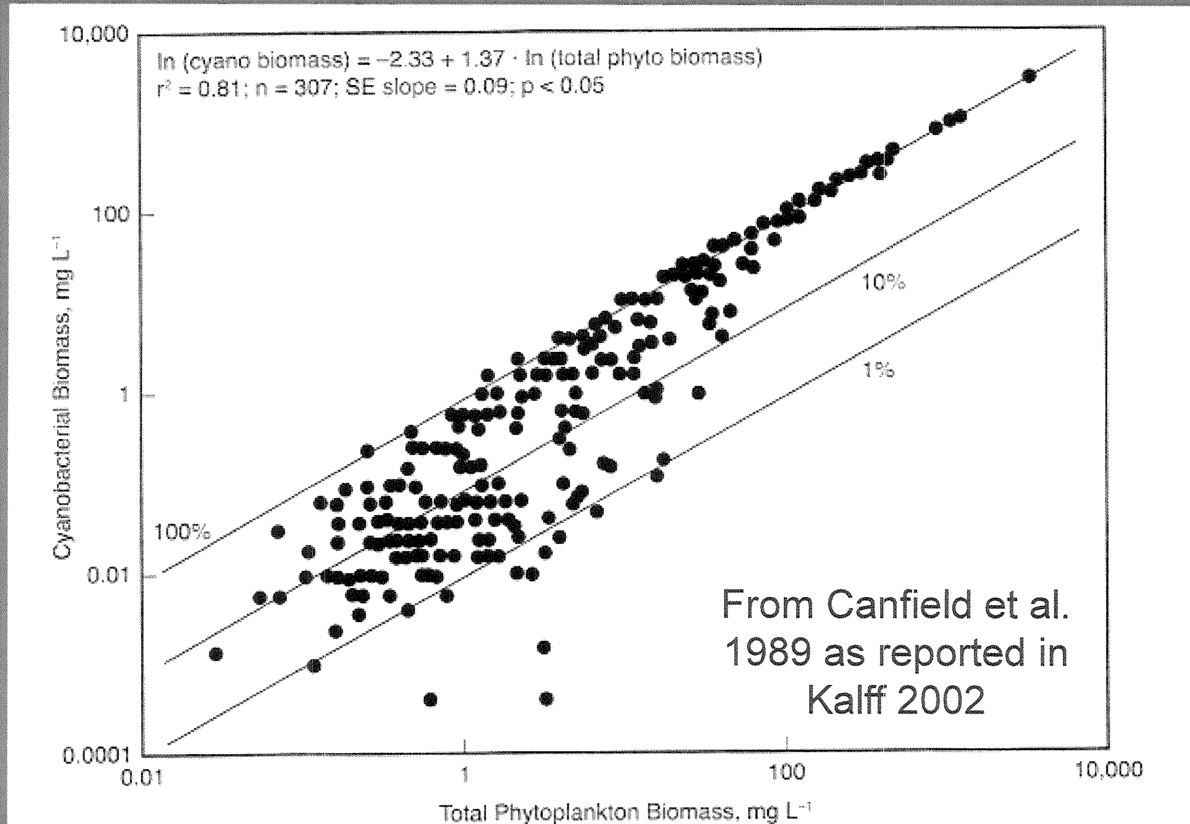



Total Phosphorus vs. Secchi Disk Transparency



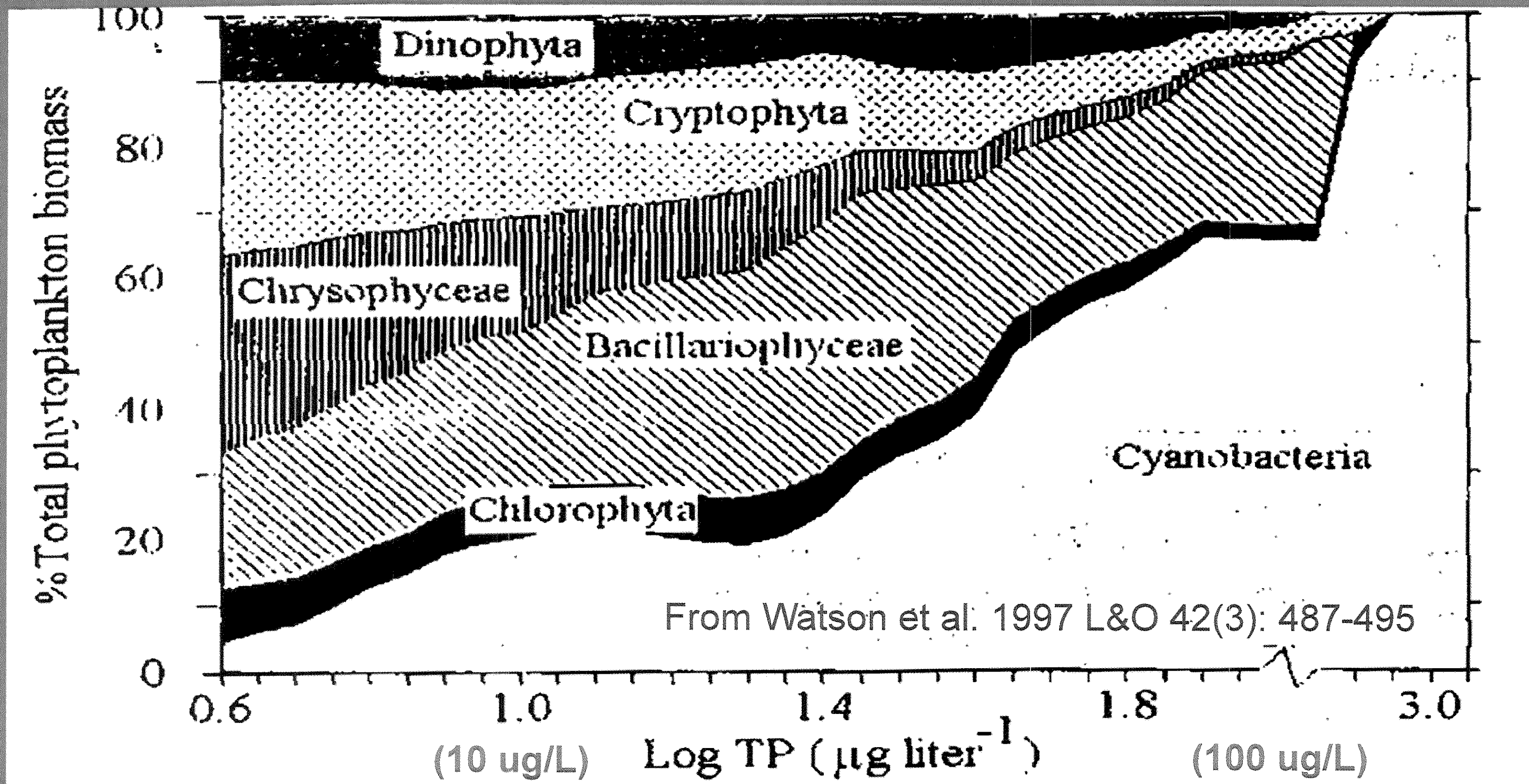

- More P leads to more algae
- More algae leads to lower water clarity

# The impact of phosphorus




– As algal biomass rises, a greater % of that biomass is cyanobacteria. So more P = more algae = more cyanobacteria.

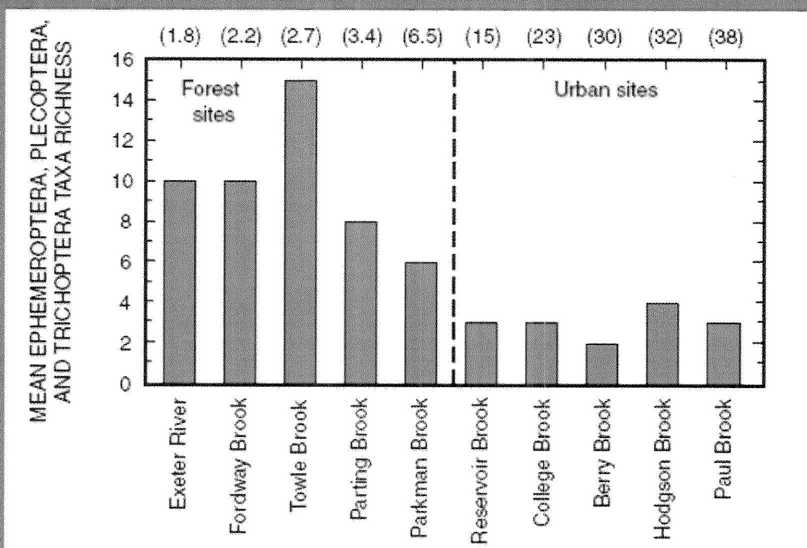
# The impact of phosphorus

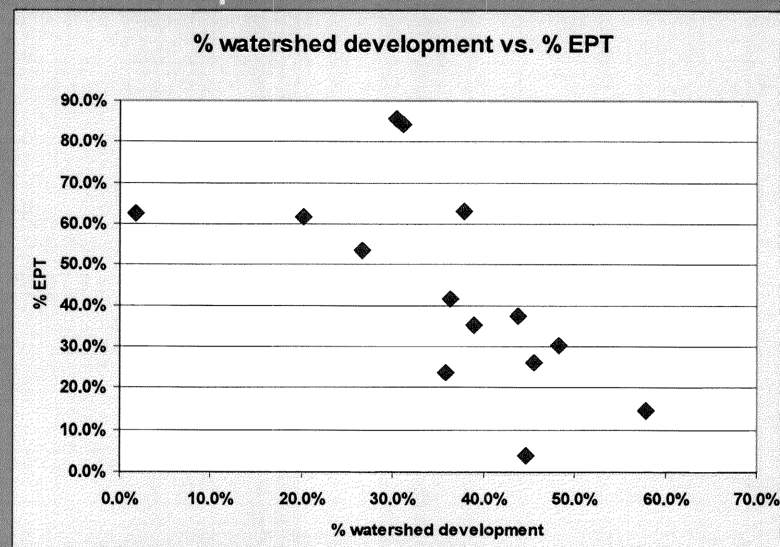



– High P leads to more cyanobacteria, possible health effects therefore linked to high P

# The impact of development

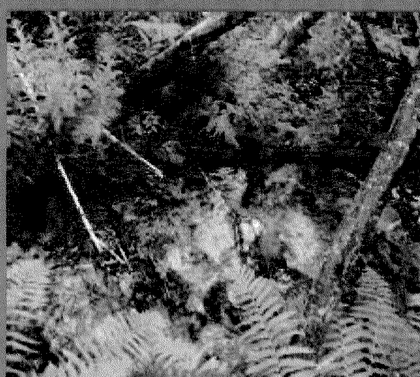
- Latest study by USGS indicates 33% change in insect community of streams with 10% impervious cover in watershed (http://water.usgs.gov/nawqa/urban/)
- Study in CT demonstrated observable changes in stream quality at impervious surfaces >6%
- Older CWP study suggested observable impact at 10%, severe degradation at 25%; other estimates: severe degradation threshold at 20-30% imperviousness



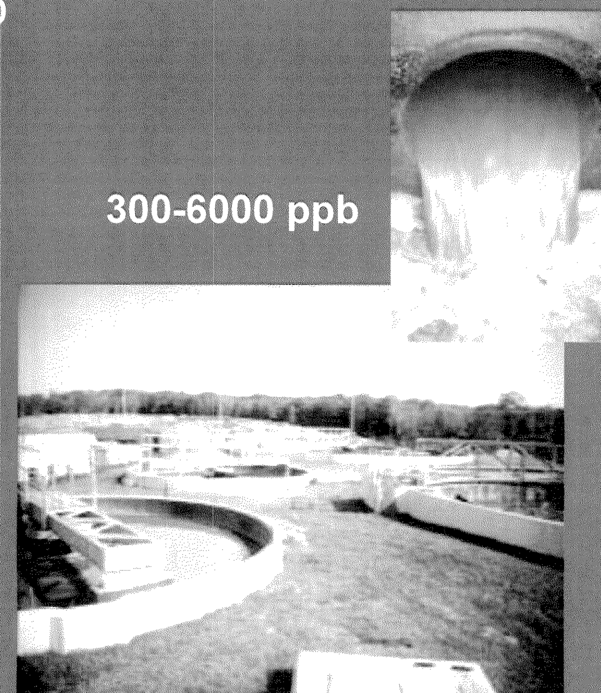
# The impact of development

- Background concentrations for P: 5-50 ppb, with an apparent threshold of impact between 10 and 20 ppb
- Runoff P concentrations: 50 to 5000 ppb, median >370 ppb
- Wastewater treatment effluent P: usually 300 to 6000 ppb, very best treatment achieves 20 to 50 ppb



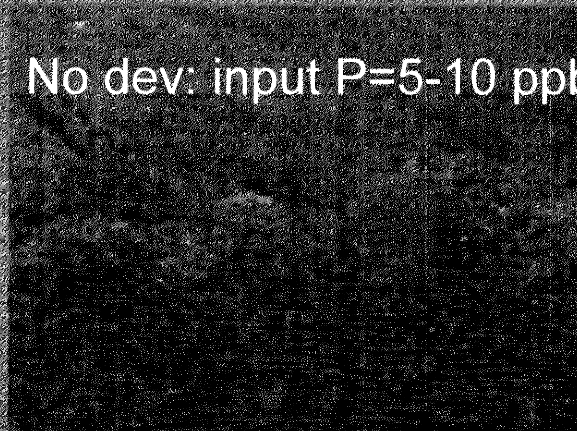
5-50 ppb

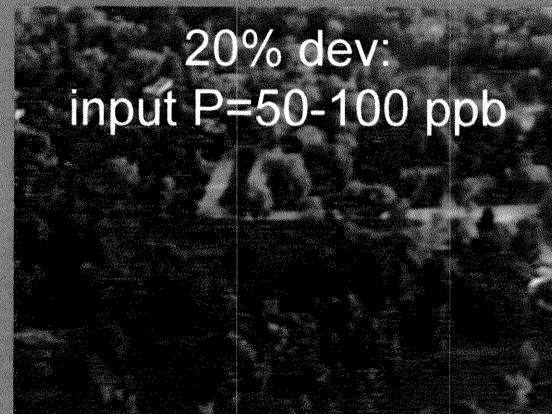
50-5000 ppb

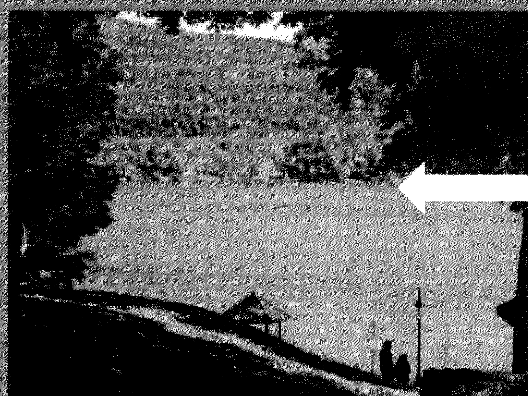


300-6000 ppb

# The impact of development



Lake George,NY: 5% developed watershed contributes same P load as remaining undeveloped 95%

75% dev:
input P= >140 ppb

Watershops Pond, MA has 75% developed watershed, input P averages 193 ppb.

# The impact of development

- How lakes process the incoming P varies substantially; flushing rate, depth, internal recycling, biological structure, inorganic suspended solids load, and other factors affect in-lake P concentration and related algal densities
- Nevertheless, higher input P leads to higher in-lake P and the problems related thereto; it is desirable to address the problems in the watershed rather than in the lake
- Note that agriculture is not being explicitly considered here, but processes (and many of the results) are the same

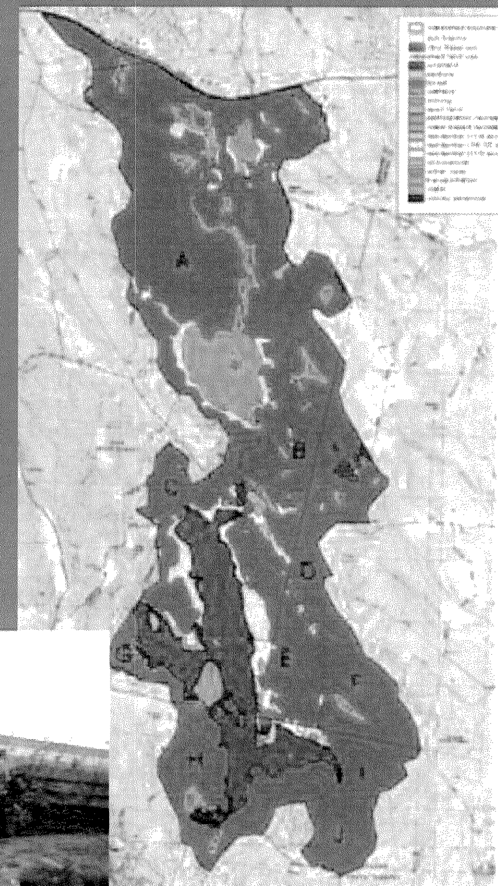


# How do we counter development impacts?

- Source and Activity Controls – Eliminate or reduce sources which generate pollutants
- Transport Reduction – Capture and remove or convert pollutants before they enter target resource
- Instream/Inlake Treatments– enhancing internal processes for pollutant inactivation
- **Ecosystem Restoration- Repair damage to resources when controls fail**

# Source Controls

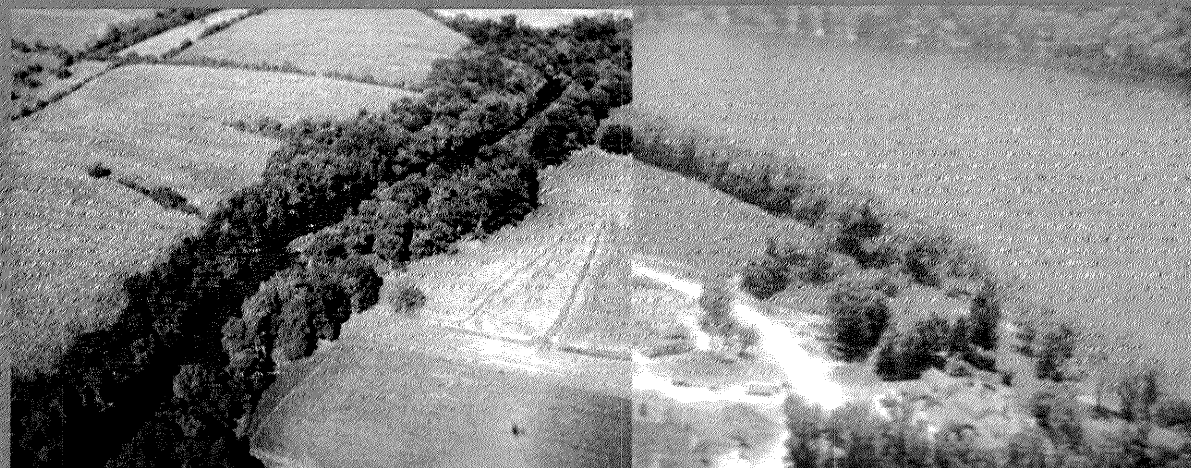
- Land use restrictions
- Material storage restrictions
- Product use limitations
- Education

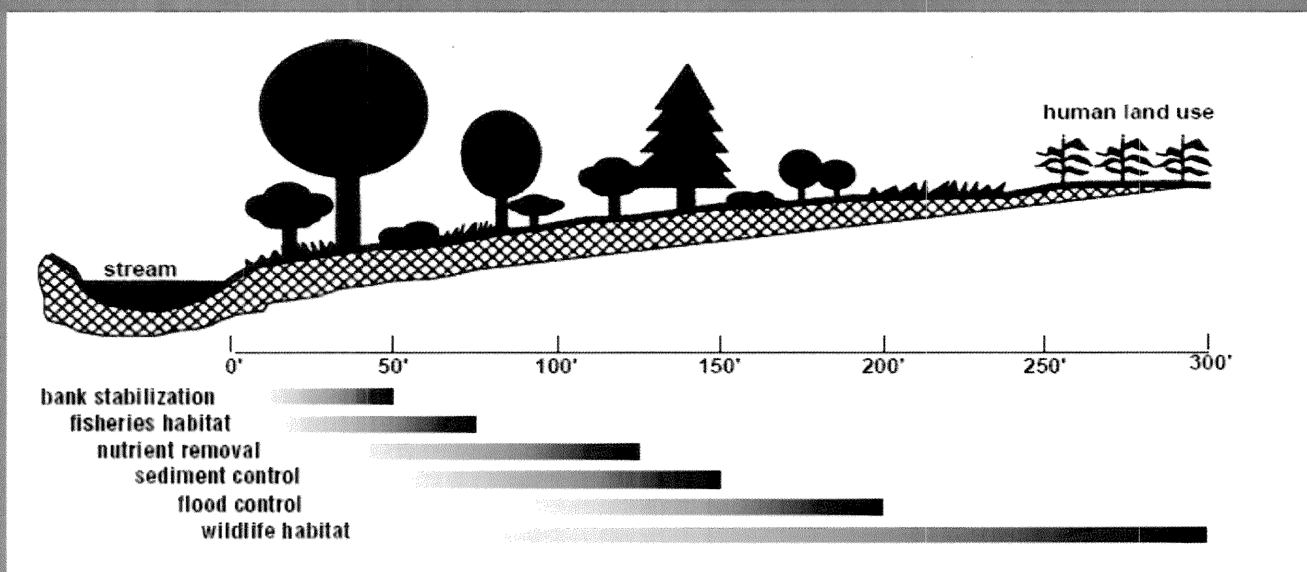




# Pollutant Trapping

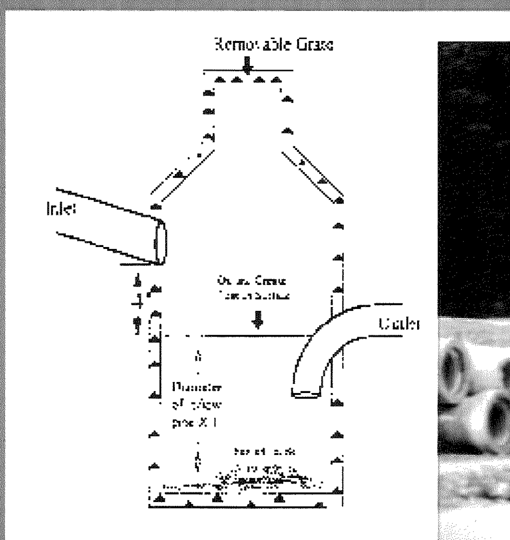
– Buffer strips: a lot more to know than just leaving some vegetated land

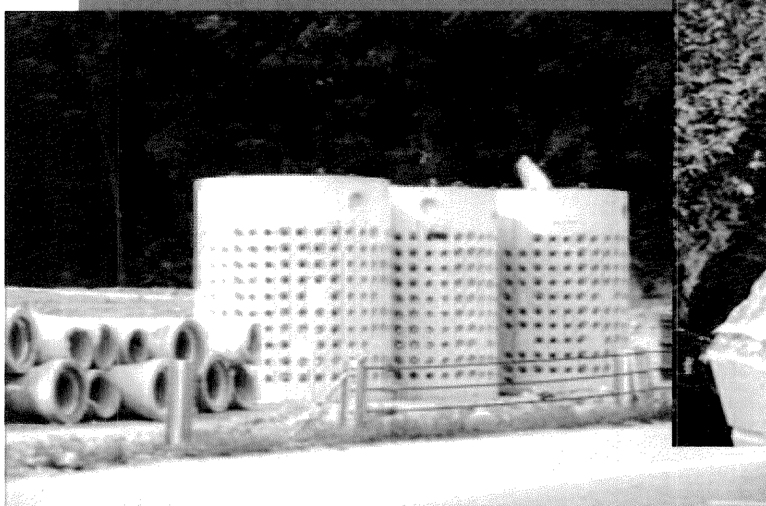


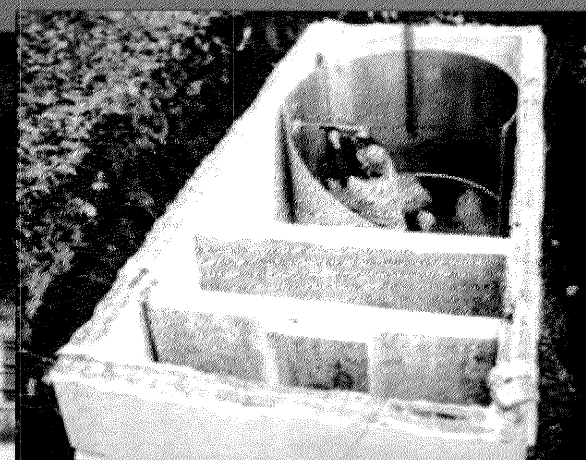


# Pollutant Trapping

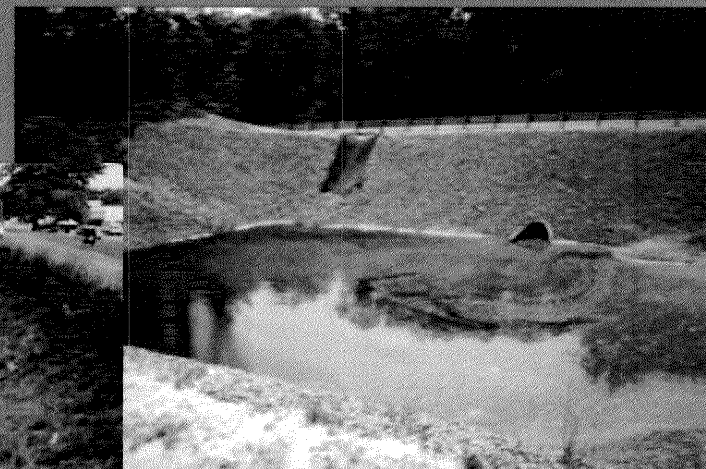
- Wide range of structural options – construction aids like silt fence, passive guards like swales, range of stormwater processing devices

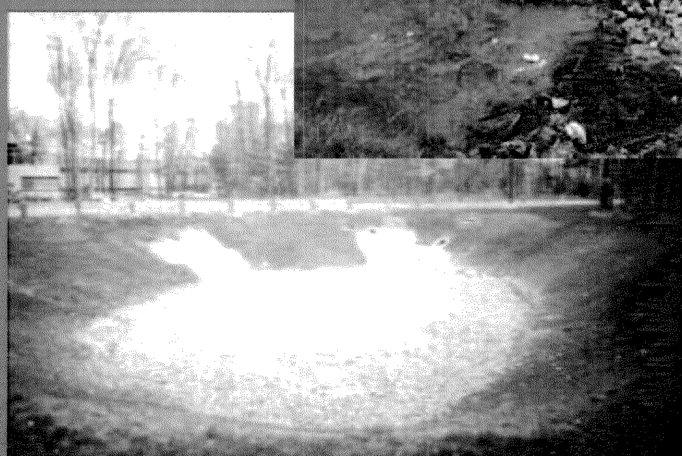




- Detention systems, infiltration basins, filtration systems

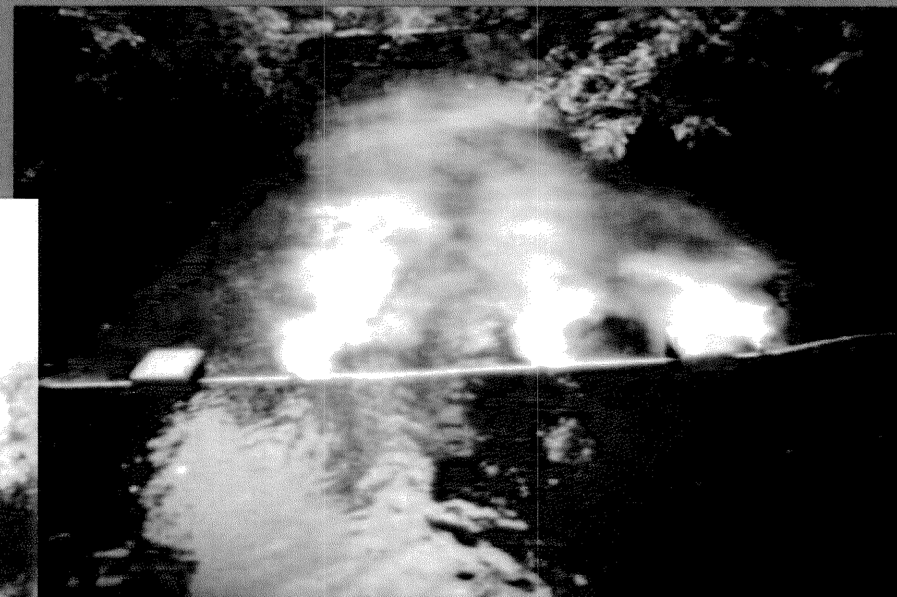




# Instream/Inlake Treatment

WRS

Creating detention within a lake or chemically treating runoff or streamflows



Aluminum treatments are becoming more common and fairly effective in short and intermediate timeframes

But these types of approaches move into in-lake treatment, which is not the focus of the vast majority of environmental programs at federal, state or even local levels these days

# Doing the math on watershed controls

- Can we get the land on the right to act like it is land on the left?

## Doing the math on watershed controls

- USEPA 1999 – summarizes capture efficiency of many pollutant trapping devices
- Center for Watershed Protection 2003 – more summary, rationale and key factors
- USEPA storm water management database – current – documented case histories from which one can infer reliable results

- Wide range of possible outcomes, means and medians provide a feel for likely results, range shows importance of understanding key factors

# Boiling it down

With reasonable implementation of Best Management Practices in a watershed, one can expect to achieve about a 50% reduction in P loading, with a probable maximum around 67%, unless extreme measures like chemical treatment or extensive infiltration are applied

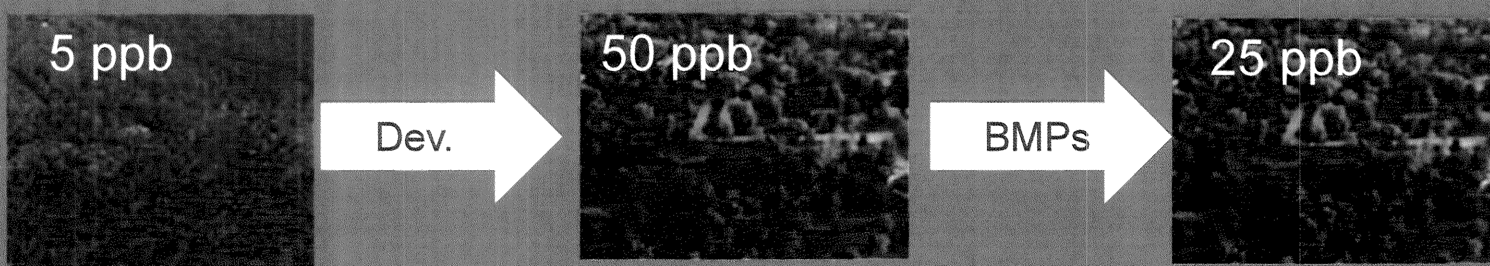
WRS

**Range and Median ( ) for Expected Removal (%) for Key Pollutants by Selected Management Methods, Compiled from Literature Sources for Actual Projects and Best Professional Judgment Upon Data Review.**

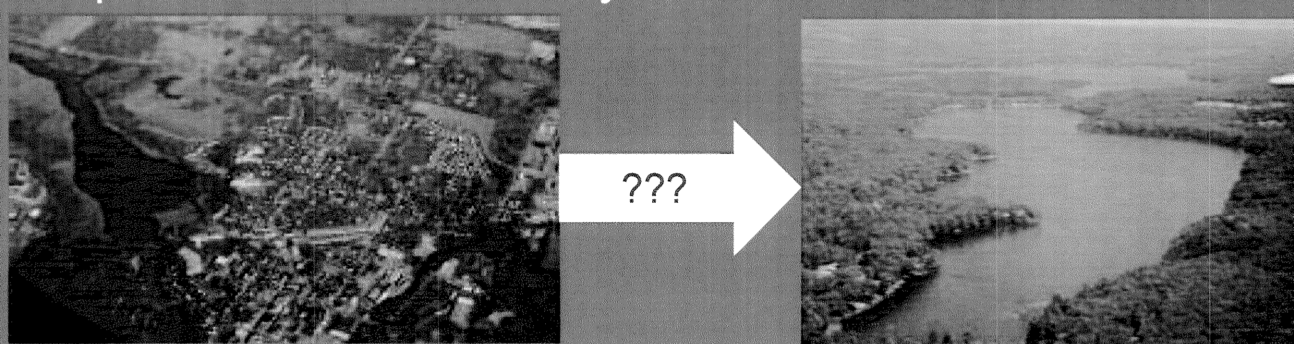
| | TSS | Total P | Soluble P | Total N | Soluble N | Metals |
|---|---|---|---|---|---|---|
| Street sweeping | 5-20 | 5-20 | <5 | 5-20 | <5 | 5-20 |
| Catch basin cleaning | 5-10 | <10 | <1 | <10 | <1 | 5-10 |
| Buffer strips | 40-95 (50) | 20-90 (30) | 10-80 (20) | 20-60 (30) | 0-20 (5) | 20-60 (30) |
| Conventional catch basins (Some sump capacity) | 1-20 (5) | 0-10 (2) | 0-1 (0) | 0-10 (2) | 0-1 (0) | 1-20 (5) |
| Modified catch basins (deep sumps and hoods) | 25 (25) | 0-20 (5) | 0-1 (0) | 0-20 (5) | 0-1 (0) | 20 (20) |
| Advanced catch basins (sediment/floatables traps) | 25-90 (50) | 0-19 (10) | 0-21 (0) | 0-20 (10) | 0-6 (0) | 10-30 (20) |
| Porous Pavement | 40-80 (60) | 28-85 (52) | 0-25 (10) | 40-95 (62) | -10-5 (0) | 40-90 (60) |
| Vegetated swale | 60-90 (70) | 0-63 (30) | 5-71 (35) | 0-40 (25) | -25-31 (0) | 50-90 (70) |
| Infiltration trench/chamber | 75-90 (80) | 40-70 (60) | 20-60 (50) | 40-80 (60) | 0-40 (10) | 50-90 (80) |
| Infiltration basin | 75-80 (80) | 40-100 (65) | 25-100 (55) | 35-80 (51) | 0-82 (15) | 50-90 (80) |
| Sand filtration system | 80-85 (80) | 38-85 (62) | 35-90 (60) | 22-73 (52) | -20-45 (13) | 50-70 (60) |
| Organic filtration system | 80-90 (80) | 21-95 (58) | -17-40 (22) | 19-55 (35) | -87-0 (-50) | 60-90 (70) |
| Dry detention basin | 14-87 (70) | 23-99 (65) | 5-76 (40) | 29-65 (46) | -20-10 (0) | 0-66 (36) |
| Wet detention basin | 32-99 (70) | 13-56 (27) | -20-5 (-5) | 10-60 (31) | 0-52 (10) | 13-96 (63) |
| Constructed wetland | 14-98 (70) | 12-91 (49) | 8-90 (63) | 6-85 (34) | 0-97 (43) | 0-82 (54) |
| Pond/Wetland Combination | 20-96 (76) | 0-97 (55) | 0-65 (30) | 23-60 (39) | 1-95 (49) | 6-90 (58) |
| Chemical treatment | 30-90 (70) | 24-92 (63) | 1-80 (42) | 0-83 (38) | 9-70 (34) | 30-90 (65) |

# Doing the math on watershed controls

- So if we have a 20% developed watershed that has gone from 5 ppb to 50 ppb as a consequence of runoff impacts, and we apply reasonable BMPs, we expect to lower P to about 25 ppb – not bad, but hardly back to “natural” – we can flirt with restoring function in watersheds with low development %



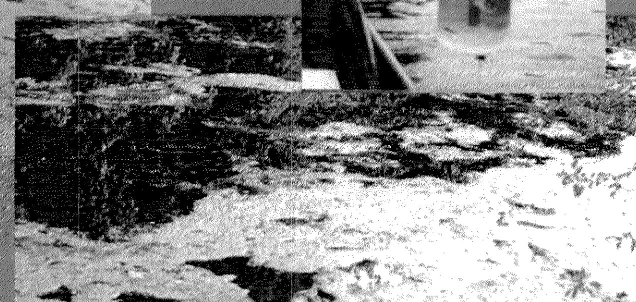

- If we have a 75% developed watershed,  P will be >140 ppb (could be >300 ppb), and even a 67% reduction by BMPs will not be adequate to reduce P to any desirable level



# Can we achieve our goals?

- If we are to meet CWA mandates through storm water management, we have to do way better than even the highest "reasonable" level expected based on experience to date
- We are going to need a different approach, or an emphasis on the techniques that yield very high removal rates (= infiltration or chemical treatment) if TMDLs are to be achieved, and many may not be realistically achievable



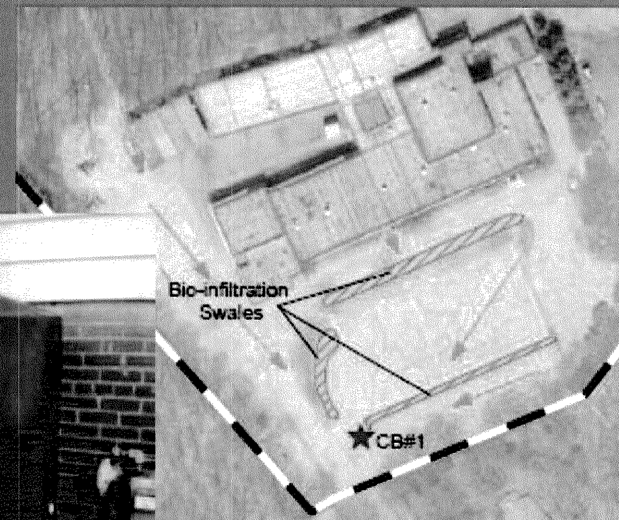



# Lawn fertilizer issue

- Dodson 2008 in Lake and Reservoir Management: Watershed feature most correlated to poor conditions was % lawn
- Lehman et al. 2011 in Lake and Reservoir Management: Ban on P in lawn fertilizer produced 25% decrease in stream P concentration.
- Cities banned or reduced fertilizer P starting in 1990s, whole states moving toward restrictions in 2000s, Scotts to remove P from most lawn fertilizer in next few years.

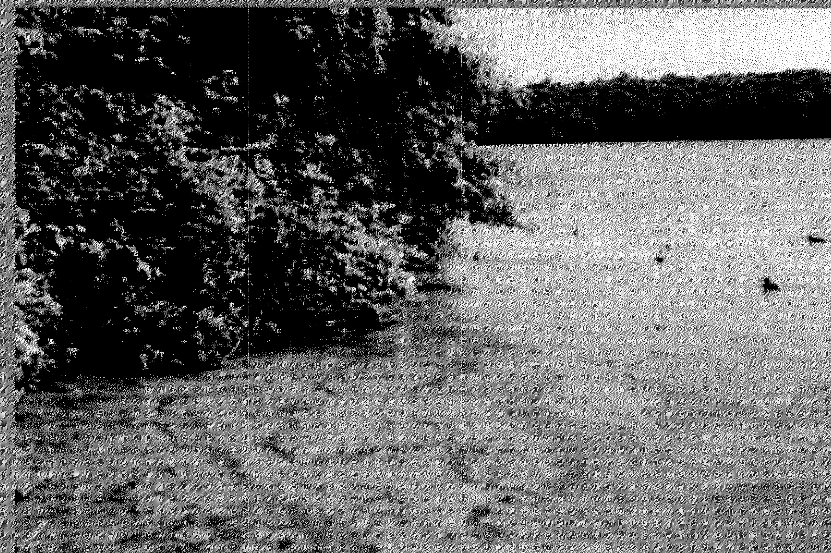
# Low Impact Development (LID)

- LID techniques seek to minimize the generation of runoff and transport of pollutants off properties
- Focus on the source, widespread application, and creativity of approaches are important aspects of LID
- A lot of good work being done, suggests higher “removal” rates than conventional pollutant trapping
- Likely to be essential if we are to counter impacts of existing and future development



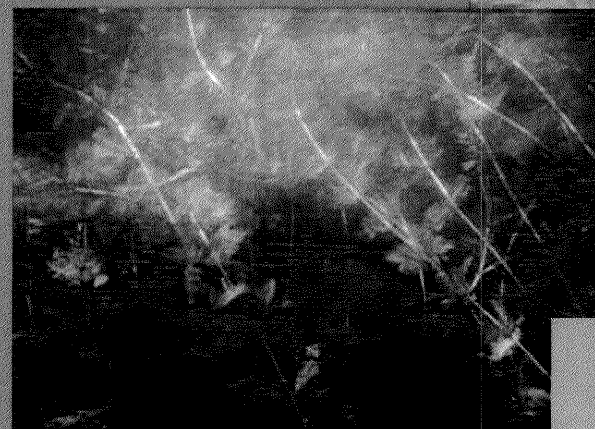

# In-Lake Management

- Techniques applied to lakes may be essential to reach water quality and use goals
- Techniques that focus on phosphorus control are particularly applicable to algae control and water clarity management
- Techniques that address rooted aquatic plants are essential to their management; no amount of watershed management will solve a rooted plant problem



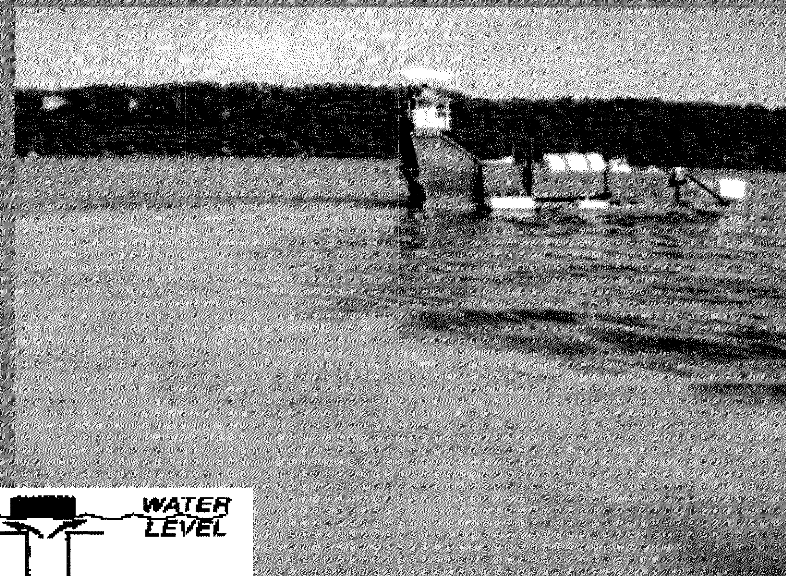
# In-Lake Management

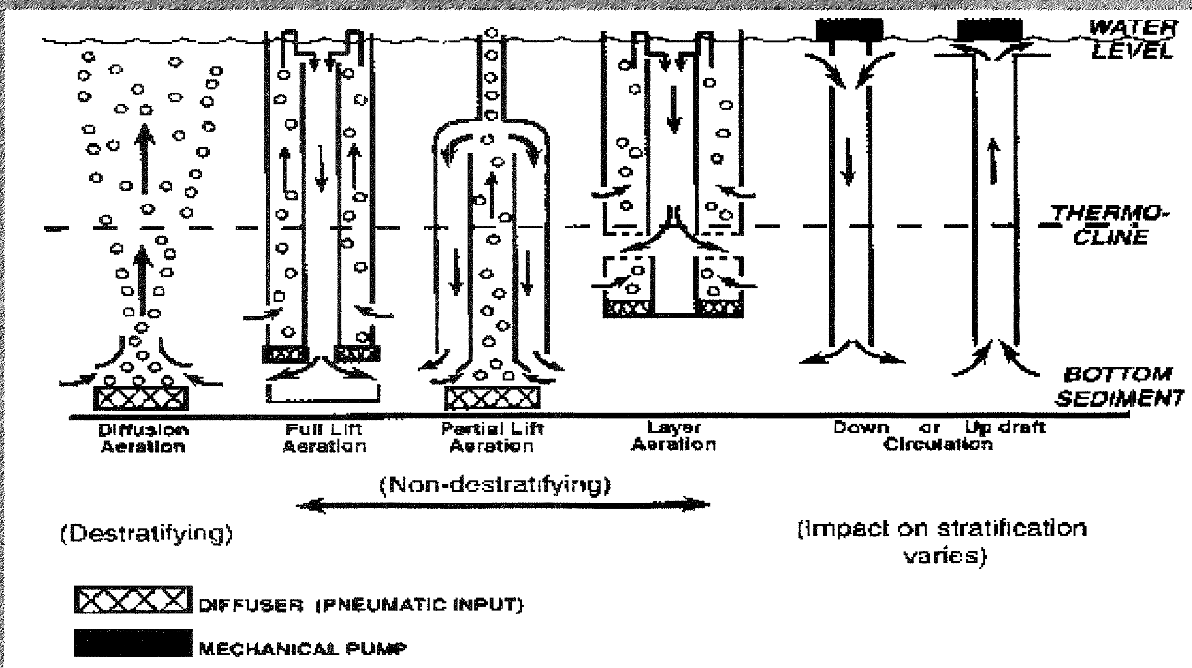
- Maine has been a leader in rooted plant problem prevention
- Maine has shown resolve in combatting infestations when they have occurred
- Maine must remain vigilant and responsive; the threat is not going away




# In-Lake Management

- Techniques like aluminum treatment and oxygenation or circulation can limit phosphorus availability
- Understanding and technology have come a long way

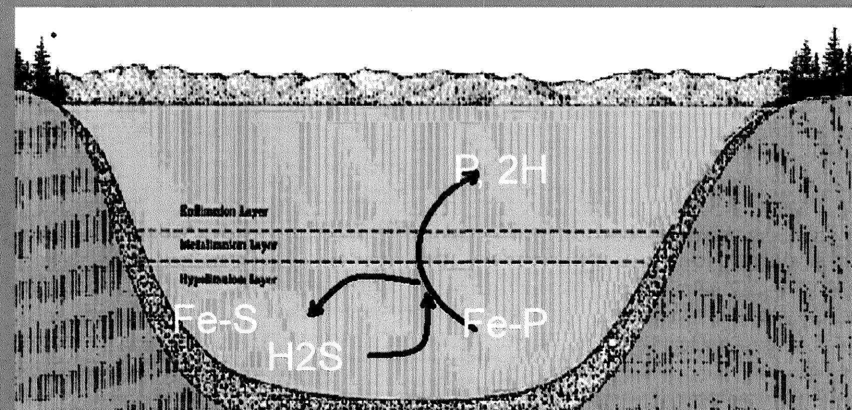





Other techniques are available, but not all are as well understood yet; implementation is less reliable

# In-Lake Management

- Internal loading supports algal blooms and promotes cyanobacteria in particular (low N:P ratio, upward diffusion, metalimnetic blooms)
- Enriched sediment can fuel cyanobacteria that rise in the water column (*Microcystis, Anabaena, Gloeotrichia* from sediment)
- Early warning that "clean" lake is becoming eutrophic, watershed management may not reverse trend, and if it does, it takes decades




# Holistic Lake Management

- Both watershed and in-lake management likely to be required; if problems are already evident in a lake, in-lake action may be top priority
- Need to consider realistic goals for rehabilitation; it may not be possible to restore some lakes to prior condition, and even if possible, it may be very expensive
- Protection deserves as much emphasis as rehabilitation; missing link in TMDL process
- Protection harder to "sell"

# The Three Legged Stool

WRS

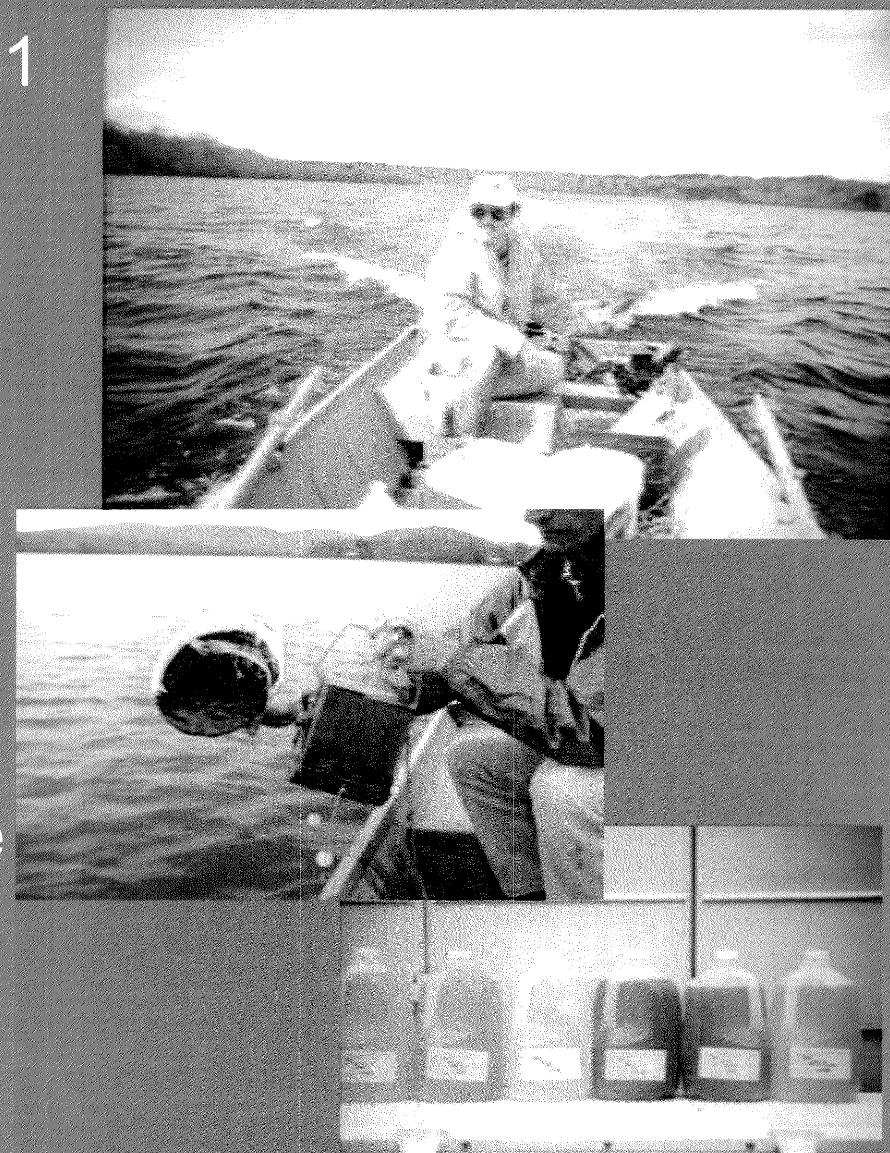
- Technical feasibility
- Economic support
- Social and regulatory systems

Being institutionally up to the challenge is at least as important as having a grasp of the scientific and economic factors governing environmental management.

And it is here that we fail more often than with the other two "legs"

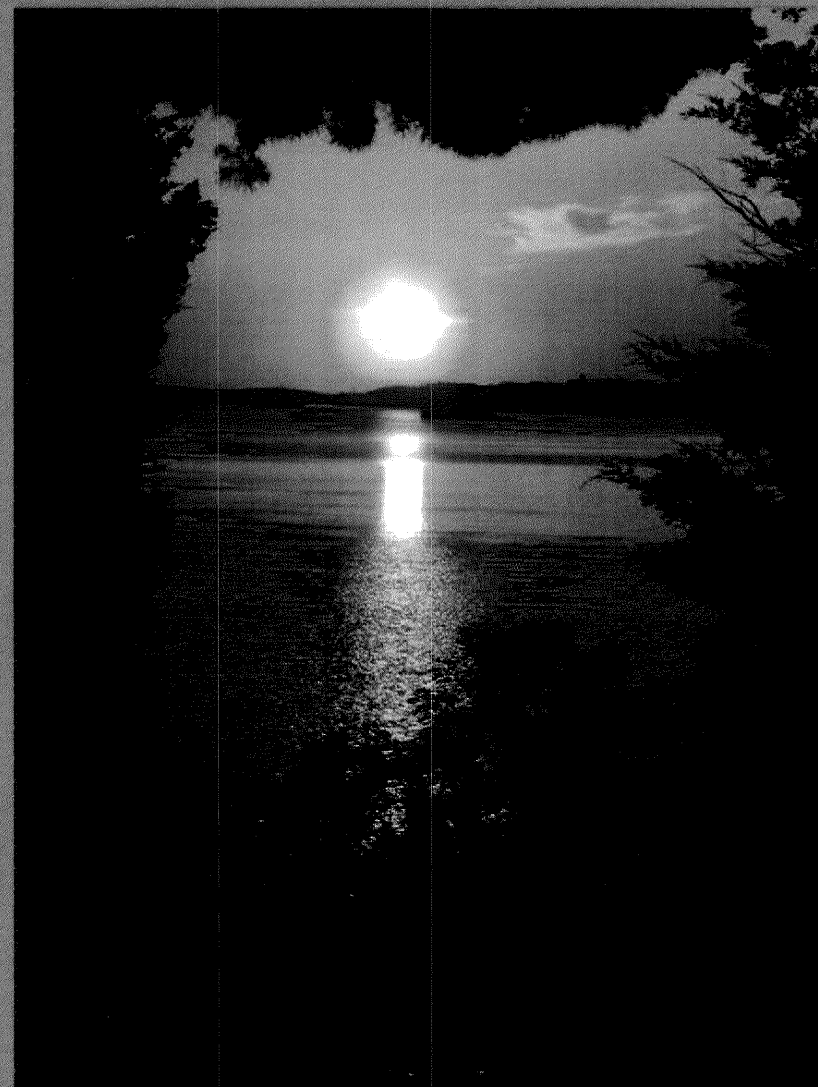
# Keys to Success

- Put protection first; the $1 in protection is worth $1000s in cure
- Effective monitoring to detect problems early (part of that $1 for protection)
- Decisive action in the watershed or lake when problems arise; adaptive management approach with understanding of trade-offs



# Conclusions

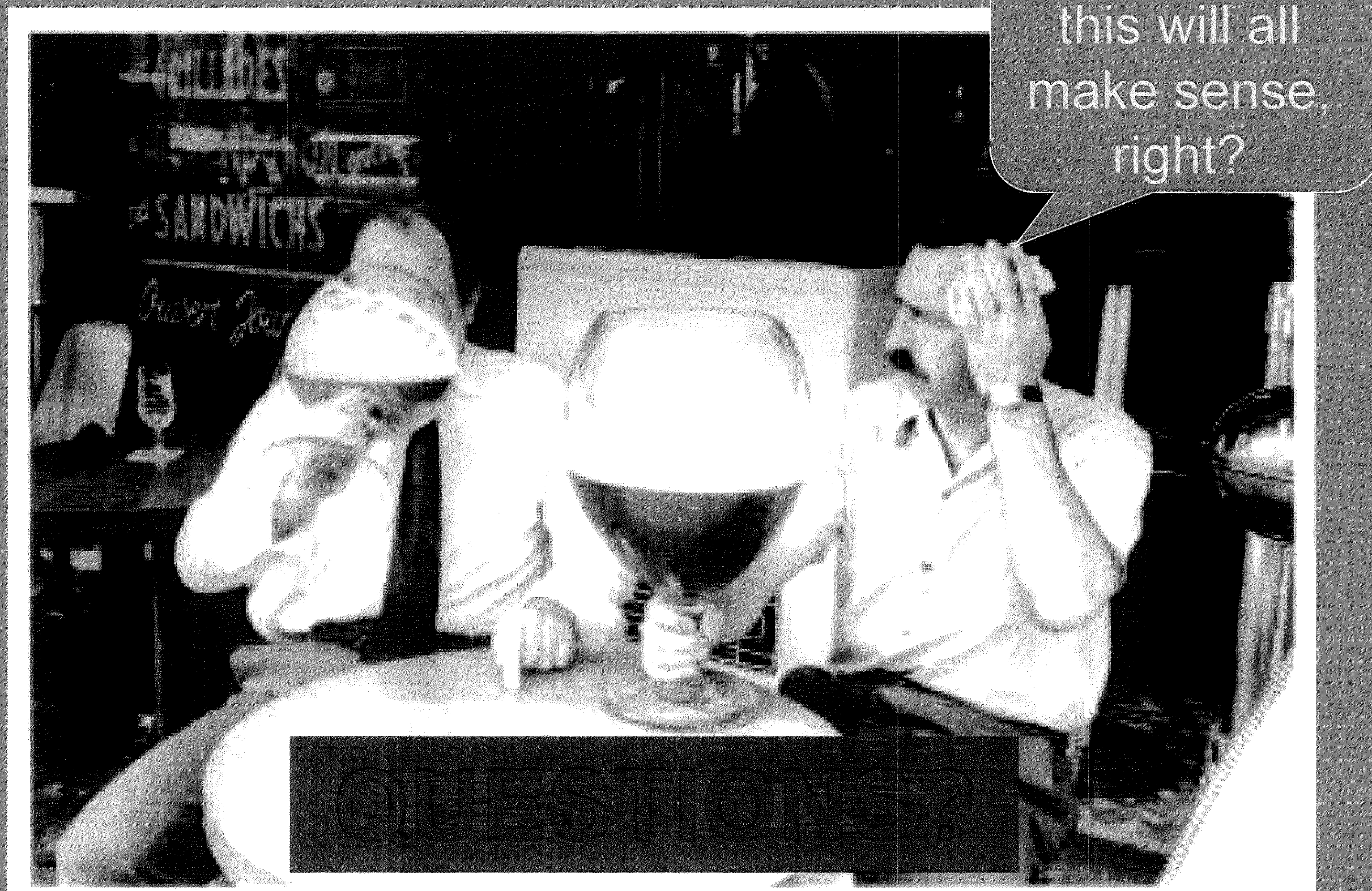
- There is a mismatch between impacts of development and countermeasures as traditionally applied; degradation outstrips remedial actions most of the time
- Other than preventing development above some threshold (10%?), there are only a few options that provide the needed level of P control
- Targeted source control, LID, and chemical treatment have the greatest applicability



# Conclusions

- TMDLs for severely eutrophied systems may not be realistically achievable with existing tools at application levels that are feasible and affordable
- Protecting lakes with currently desirable conditions would appear to deserve higher priority than some restoration efforts
- Successful lake management requires vigilant monitoring and decisive action in an adaptive management approach

# The End


SANDWICHS
One more and this will all make sense, right?
QUESTIONS?